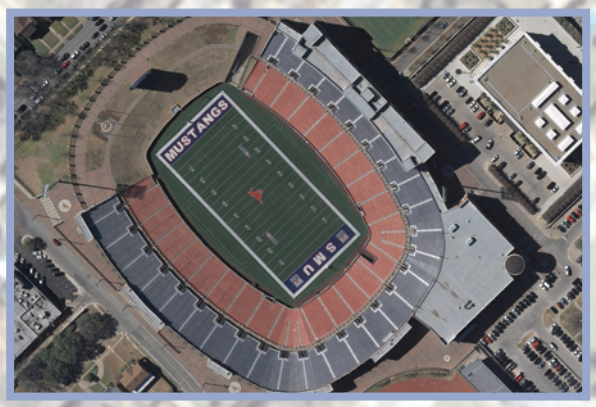
Bohannan Huston Deploys Four Digital Mapping Cameras in Massive Texas Acquisition Project

by Dennis Sandin

Acquisition Succeeds Despite Enormous Size, Tight Schedule



Southern Methodist University Football Stadium.


TXDOT drainage pond.


A private maze garden.

Exhaustive planning and constant communication enabled a team led by Bohannan Huston Inc. (BHI) to complete the aerial acquisition phase of an enormous photogrammetric mapping project nearly two weeks ahead of schedule in March 2007. The acquisition, which covered 13,715 square miles in and around the Dallas-Fort Worth area, involved the simultaneous coordination of four aircraft flying Intergraph Digital Mapping Cameras (DMC).

"The sheer size of the project and the narrow January-through-March acquisition window posed a significant challenge that was complicated by two busy airports," said Dennis Sandin, senior vice president of BHI, which sub-contracted the aerial work to 3001 Inc. and Photo Science. "This project was a huge coordination effort."

Sandin explained that to maintain the flexibility required for operation in the busy airspace above Dallas-Fort Worth Airport and Love Field, all flight lines had to be planned and approved months before the first day of flying. And the uncertainties of weather and air traffic necessitated continuous communication among the companies, their pilots, ground control crews and Air Traffic Control (ATC) as acquisition targets changed and had to be re-assigned throughout any given day.

Alleviating some of the uncertainty, however, was the performance of the DMCs. BHI sub-contracted to have four cameras involved in the project, primarily to cover the sprawling land area in a short time, but also to provide a measure of redundancy in the event of a hardware, software or aircraft problem. Fortunately, no out-of-the-ordinary maintenance issues were encountered with the DMCs, and this contributed significantly to the ahead-of-schedule project status.

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One the many new urban developed areas of Dallas/Fort Worth.

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Mapping 17 Counties

In addition to serving as a blueprint for large-area photogrammetric mapping projects, the Dallas-Fort Worth endeavor is a study in intergovernmental cooperation. The color orthophotos, contour maps and digital elevation maps generated will ultimately be accessed by 17 counties, dozens of cities and numerous government agencies at all levels, including FEMA and Texas Department of Transportation (DOT), collectively represented by the North Central Texas Council of Governments (NCTCOG).

By cooperating to fund the $2.6 million project, the NCTCOG is able to obtain photogrammetric mapping with a frequency and at a level of detail that many participants could not afford on their own. The consortium has established a two-year update cycle for its base mapping, which calls for six-inch pixel resolution in the orthophotos and two-foot contours in the elevation maps.

"Our biggest goal is saving the tax payer money," said Mark Eder, district survey coordinator for Texas DOT, which assumed the leadership role in this year's mapping. "The price of this project is minimal compared to the cost savings."

Within the state DOT alone, the orthophotos and elevation maps will be used in pre-planning and design work on all transportation projects from road striping and paving to highway widening and construction. The 2007 images will be compared with those from 2005 so the state can see where growth is heading and expand the transportation network accordingly.

Texas DOT's Eder explained that six-inch resolution is a necessity for transportation planning. At that level of detail, the planners and engineers can identify features as small as manhole covers and even lane stripes. The value of sharp, crisp orthophotos is tremendous, according to Eder, because countless time-consuming trips into the field by Texas DOT personnel are eliminated due to the fact they can identify and map important roadway features from their desktops.

In the RFP for the 2007 project, Texas DOT specified that Intergraph DMCs were to be used. BHI, which also won the prime contract for the 2005 Texas mapping, was happy to comply because it routinely uses the digital cameras and originally introduced Texas DOT to them during that earlier project. BHI selected 3001 Inc. and Photo Science as subcontractors because each owns multiple DMCs.

An Intergraph Image Station Automatic Triangulation (ISAT) Pass point of a horse's shadow.

Lake Tawakoni in Hunt County Texas.

"We like the quality and clarity of the [DMC] images," said BHI's Sandin. "We also appreciate that it's a frame-based sensor that can work in the same processing workflow with the off-the-shelf software that we use for our film-based processing."

The DMC was designed as an aerial photogrammetric system to support missions requiring high resolution and accuracy. It has a rigid imaging geometry almost identical to traditional 9x9-inch aerial film cameras. Automatic forward motion compensation and rapid refresh rate provide the flexibility to fly the system at both low and high altitudes for collection of either large- or small-scale imagery.

According to Eder, the quality of the DMC color balancing and accuracy of elevation extraction in the 2005 project played major roles in convincing Texas DOT that the cameras should be used again in 2007.

Planning Complex Acquisitions

Having served as prime contractor for the 2005 Dallas-Fort Worth project, BHI had learned some valuable lessons in dealing with the complicated airspace around the airports, but a major change in the 2007 project was the near doubling in total square mileage. Texas DOT knew the approximately 10-week leaf-off flight window was tight and requested multiple cameras, which presented a unique set of mission planning challenges. Photo Science and 3001 would each bring two cameras to the project, meaning that four aircraft might be in the air at any time.

"The most important decision we made at the outset was to select one person to handle all flight planning," said Sandin, explaining that this eliminated confusion over responsibilities and established a single contact point for communication among all parties. That person was Ray Brouillette, general manager of 3001 Inc.'s Louisiana Civil Works Office.

During pre-planning, BHI and Texas DOT divided the project area into blocks roughly equal in size to about 1800-2000 image frames, considered manageable data sets for processing purposes. Block shapes were determined by an existing network of ground control points used in earlier projects. These were provided to Brouillette to modify as needed and then plan the actual flight lines using the Intergraph Mission Planning software.

"We realized it wasn't practical to assign blocks or areas to specific aircraft in advance because individual daily flight plans would vary based on weather and access to airspace," said Brouillette. "Instead, we planned flight lines for every block and provided all of those planning files to each of the four flight crews for entry into their [DMC] Airborne Sensor Management System."

This software interfaces with onboard GPS navigation devices and guides the pilot in following the planned flight lines. The onboard management system also triggers the camera shutter at selected points.

"This gave each flight crew the information they needed to switch to different flight lines as conditions dictated during the day," said Mark Meade, Photo Science Vice President. "It also meant they had to keep in constant communication with each other to avoid duplicating flight lines and to stay out of each other's airspace."

In the busy air spaces around Dallas-Fort Worth Airport and Love Field, ATC had the final say as to where the four aircraft could fly on a particular day. To keep the controllers informed, the pilots filed typical flight plans detailing where they would like to fly that day. Every morning, BHI faxed to ATC a set of FAA aeronautical charts with proposed flight lines overlaid on them.

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"We wanted to make the process as easy and efficient as possible," said Brouillette, explaining that these plans and maps gave controllers a heads-up regarding the areas flight crews wanted to cover. As winds and air traffic changed, ATC radioed one or another of the four aircraft and diverted it into, or out of, a particular block, sometimes for as little as 15 minutes at a time. In between those times, the crews could travel to flight lines outside the air traffic control area and continue the acquisition process, nearly eliminating wasted flight time.

In 2005, the six-inch pixel specification required the aircraft to operate at 4,800 feet above ground level, which put them in the busiest and most-controlled portion of airspace above the two airports. This time, by flying just 700 feet higher, the flight crews would have much greater freedom to fly with less control by ATC. "The higher altitude meant our pixel size would be 6.75 inches instead of six inches, but it also meant we would be able to fly the entire project area in the time allotted," said Sandin.

BHI conferred with Texas DOT, which was well aware of the problems of flying in controlled airspace. It agreed to allow the teams to collect the lower resolution photography over the airports provided the deliverables were over-sampled to six-inch pixel size.

Leveraging an All-Digital Workflow

The four aircraft ultimately flew more than 15,700 linear miles in 562 flight lines and collected 65,000 image frames. This represented a huge volume of digital data. The first step in processing occurred immediately upon landing when the crews removed the hard drives from the cameras and carried them to their temporary base at the Mesquite, Texas, airport for duplication.

3001 and Photo Science typically shipped the back-up copies on Firewire drives to archive facilities, while the originals went to each company's respective headquarters for initial processing. This step generates unrectified three-band (natural-color) image files from the raw data sets. Once the imagery comprising an entire block has been created, the digital files are sent to BHI in Albuquerque for orthorectification, elevation extraction and production of final deliverables. Additional sub-contractors were used for the production work, which began in late spring 2007.

The size of the Dallas-Fort Worth mapping project will continue to provide challenges throughout the processing phases due to the volume of digital data that has been acquired. Commenting on the processing challenges, BHI's Sandin said, "The secret [to success] is that we have an all-digital workflow."

BHI has developed this digital processing environment with Intergraph GeoMedia running on top of an Oracle Spatial XE database. BHI programmers have used these two systems to build all of the applications needed to perform the aerotriangulation, color balancing, orthorectification, mosaicking and tiling of the imagery products. The entire workflow will be monitored and managed through GeoMedia.

Managers can query the spatial database through the GIS tools to determine where any data set is and what its processing status is at any time. The company plans to make this status information continually available via the web to Texas DOT, NCTCOG and the processing sub-contractors so that everyone can get a feel for how the project is progressing in real time.

Once production begins, Sandin expects the remainder of the project to proceed as smoothly as the acquisition. "The hard part of a project like this is planning," he said. "If you get that right, everything else should be right on schedule."

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